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ICT Adoption in the Danish Facilities Management Supply Chain - What are the factors that matter?

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Abstract
This paper presents the results of a study of factors impacting information and communication technology (ICT) adoption in the supply chain of facilities management in Denmark. The research questions addressed in this study are: What are the key factors that influence adoption and assimilation of ICT systems in the supply chain of facilities management? By taking the starting point in the literature of supply chain, supply chain management, facilities management and ICT adoption and assimilation a semi-structured interview guide has been developed and 12 in depth interviews have been conducted. The results show that there are a number of factors that influence adoption and assimilation of ICT in the supply chain of facilities management in Denmark, which have been grouped into organizational, technology and external environmental factors. The study is relevant to researchers of ICT adoption and facilities management as well as facilities and ICT managers alike.

1. Introduction

In the last decade or so, companies have outsourced many of the corporation's functions to external suppliers. The driver for outsourcing being the ability to shift non-core services out of the organization, to allow the organization to better focus on the proprietary functions - those functions that give the organization the competitive advantage. This is also the case for non core-services such as Facilities Management – FM (e.g. Rogers, 2005; Ventovuori, 2006). Organizations need to ensure they do not lose sight and control of the outsourced service provider, especially if the supplier becomes dependent on driving up volumes in order to remain profitable, to the detriment of quality and innovation (Rogers, 2005). Thus, lately, the role of supply chains and their management has increased importance (Christopher, 2000; Moberg et al., 2003). In addition, supply chains in every industry are moving toward integration as the demands on individual organizations have become too vast to allow them to continue operating in isolation (e.g. Rogers, 2005; Christopher, 2000; Skipper et al., 2008).

The advent of Web technologies and related supply chain management systems is also facilitating planning, collaboration and integration of supply chain partners (e.g. Johnson and Whang, 2002; Rudberg et al., 2002). However, the adoption and assimilation of these ICT systems to support the supply chain is often largely contingent upon the extent to which the system is assimilated internally and diffused among networks of business partners in a supply chain (Ranganathan et al., 2004). Previous literature on Interorganizational Systems (IOS) or EDI adoption have showed that such adoption process is not easy and there are a number of factors that influence it.

In this study we focus on the factors that affect adoption and assimilation of ICT systems for FM supply chain and investigate the following research question: What are the key factors that influence adoption and assimilation of ICT systems in the supply chain of facilities management? FM is defined here as a support activity supplying facility services to support

the demand of the primary activities in an organization, thus facility management is a specific type of service management (Jensen, 2008).

Few studies have investigated SCM in the facilities business (e.g. Vandaele and Gemmel, 2007) and none have focused on the factors affecting ICT adoption in the facilities management supply chain, therefore the contribution of this study. This study is important because the answer to the research question generates new knowledge about factors affecting ICT systems adoption in the supply chain of the facilities management industry, which might be of interest to scholars and practitioners in the fields of facilities management, IT adoption and operations management.

This paper is based on a research report by Scupola and Jensen (2009) and the paper is structured as follows. In this introduction, the background and the research questions have been introduced. The second section gives a brief overview of the FM market in Denmark with particular focus on the use of ICT services. The third section provides a literature review of SC and SCM as well as a short description of FM is given. The fourth section introduces theory of adoption and diffusion of ICT with special focus on interorganizational (IOS) systems and web-based systems, and a model used in the study is presented. In the fifth section the research method is described, while the sixth section presents the study's results. Finally the seventh section will discuss the results and give some concluding remarks.

2. The FM market in Denmark

According to a study by Centre for Facilities Management – Realdania Research (Jensen, 2009a and 2009b) the total potential Danish FM market in 2008 was € 7.9 billion and the actual Danish market for FM in 2008 was at € 4.9 billion. The size of the FM market should be seen in the context of Denmark being a small country with 5.5 million inhabitants. The degree of outsourcing of FM services is 62 %. The study was based on telephone interviews covering 375 public and private organisations, including 272 FM customer companies and 103 FM providers.

The services that are mostly offered and demanded include Space, Outdoors, Cleaning and Workplace, Health, Safety & Security and ICT. Among the clients 85 % used ICT services and out of these 75 % carried out some or all services in-house, while 49% had some services outsourced, and 23 % of the providers in the survey offered ICT services (Jensen, 2010).

3. Literature Review of Major Concepts

Three main streams of literature form the theoretical background of this study: the literature on supply chain management (e.g. Christopher, 2000; Moberg et al., 2003), the FM literature (e.g. Jensen, 2008; Alexander, 1996), and the innovation diffusion literature (e.g. Rogers, 1995). This section provide brief reviews of the literature on supply chain management and FM, while section 4 will go deeper into the ICT related innovation diffusion literature.

3.1 Supply Chain Management

There are many definitions of supply chain and supply chain management (SCM). Supply chain management takes a systems view regarding all activities and functions that are needed

to bring a product or service to market (Sanders, 2007). For example Cooper et al. (1997) define SCM as
"The integration of business processes from end users through original suppliers that provides products, services and information that adds value for customers".

Christopher (2005) defines SCM as
"The management of upstream and downstream relationships with supplier and customers to deliver superior customer value at less cost to the supply chain as a whole (p. 5)".

In addition Christopher (2005) defines the supply chain as
"a network of connected and interdependent organizations mutually and cooperatively working together to control, manage and improve the flow of materials and information from suppliers to end users (p.6)".

According to Akkermans et al. (1999) it is possible to detect some common characteristics in the various SCM definitions:

- *"involves multiple echelons, processes and functions like, for example, suppliers, purchasing, manufacturing, distribution, marketing, sales, and customers;*
- *Clear focus on the coordination and/or integration*
- *Main aim is to achieve a simultaneous increase in customer service and profitability (p. 567)"*.

The supply chain management concept has traditionally centered on the manufacturing industries (Zdisin et al., 2000) and according to Vandaele and Gemmel (2006) only a few studies have investigated SCM in the service industries (e.g. Ellram et al., 2004; Mabert and Venkataraman, 1998). However in services, and especially facilities services, SCM is becoming more and more important due trends such as outsourcing (Li et al, 2006). In services SCM deals rather with customer-supplier dyadic relationships than with the unidirectional movement of physical goods (Fitzsimmons and Fitzsimmons, 2006; Sampson, 2000).

3.2 Facilities Management

There are many definitions of facilities management (e.g. Then, 1999; Nutt, 2000). According to Jensen (2008) the European Standard FM definition is the most widely adopted in Europe. This definition is:
"Facilities management is the integration of processes in an organization to maintain and develop the agreed services, which support and improve the effectiveness of the primary processes (Jensen, 2008, p. 10).

According to Pathirage et al. (2008), another definition frequently used describes FM as:
"... An integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of that organization (Pathirage et al., 2008, p. 5)"

These definitions implies that the processes or the activities of an organization are divided into primary and support activities (e.g. Porter, 1980) and FM is an activity supplying facility services to support the demand of the primary activities in an organization (Jensen, 2008). In this study by applying the above definition of supply chain (Christopher, 2005) to facilities management, we define the facilities management supply chain as *a network of connected and interdependent organizations mutually and cooperatively working together to control,*

manage and improve the flow of facilities services and information from suppliers to end users.

Pathirage et al. (2008) argue that the FM literature (e.g. Amaratunga, 2001) identifies four generations of FM that focus on the changes to the management of facilities over the last few decades. In the first generation FM was considered as an overhead to the organization and was something that had to be managed for minimum cost rather than optimum value. In the second generation, FM took a process perspective and promoted the process focus between the organization's individual businesses and the FM organization by making FM activities within the organization a continuous process (Amaratunga, 2001 in Pathirage et al., 2008, p. 8). In the third generation, FM becomes more concerned with resource management, concentrating on managing supply chain issues associated with the FM functions. Finally the fourth generation focuses on the alignment between organizational structure, work processes and the enabling physical environment arguing that the organization's strategic intent must clearly reflect the facilities dimensions in its strategic business plans.

This paper does not take into consideration such strict distinction and is mainly positioned in the third generation of FM according to Pathirage et al. (2008). These are however just background concepts for investigating and understanding the factors impacting ICT systems adoption in the FM supply chain. Therefore it can be that some factors affecting ICT adoption and diffusion are more relevant at strategic level, others are more relevant at tactical and operational level, while some are important at all three levels.

4. ICT Adoption and Diffusion and Supply Chain

For many decades, intermediaries within a supply chain have used electronic data interchange (EDI) and other types of information technology to send data electronically between different firms. This service was costly, and traditional EDI was cost-prohibitive for small and medium sized firms (Lancaster et al., 2006). Today the public internet and web based applications are making exchange of information within the supply chain much easier and cheaper (Wang and Zhang, 2005), and consequently many more firms, including small and medium size, are adopting ICT systems in their supply chain management activities.

The innovation diffusion theory (e.g. Rogers, 1995) has been extensively used in studying technology adoption and implementation as well as in the identification of the factors that facilitate or inhibit technology adoption and implementation (e.g. Grover and Goslar, 1993; Ranganathan et al., 2004). Several researchers have identified the factors or group of factors that affect IT adoption and diffusion in an organization (e.g. Jeyaraj et al., 2006) and more recently and to a lesser extent in a supply chain context. Ranganathan et al. (2004) by conducting an extensive review of the literature on IT, IOS, EDI adoption and diffusion and SCM identified 2 main groups of factors that affect IT adoption and diffusion in the supply chain: the external environment of the firm and the internal organizational environment. Within these two groups they identified six factors that are important in web-based systems adoption and diffusion in the supply chain of the extended enterprise: supplier interdependence, competitive intensity, IT activity intensity, managerial IT knowledge, centralization, formalization of IT unit structure.

Ranganathan et al. (2004) expect that the three factors from the organizational environment (managerial IT knowledge, centralization, and formalization) are associated with internal assimilation of Web technologies and systems, while the three factors pertaining to the external environment (supplier interdependence, competitive intensity, and IT activity intensity) are associated with the external diffusion of Web technologies and systems in the supply chain management. The importance of factors belonging to the organizational environment as well as to the external environment has been showed in a number of studies (e.g. Fichman, 2000; Jeyaraj et al., 2006). However other studies have found that the characteristics of the technology itself might be important in the adoption and diffusion process both at organizational (e.g. Rogers, 1995; Tornatzky and Fleischer, 1990) and supply chain level. For example in a study of adoption of mobile technology in the supply chain, Doolin and Ali (2008) found that three key attributes of the technology have an impact on its adoption in the supply chain: relative advantage, compatibility and complexity.

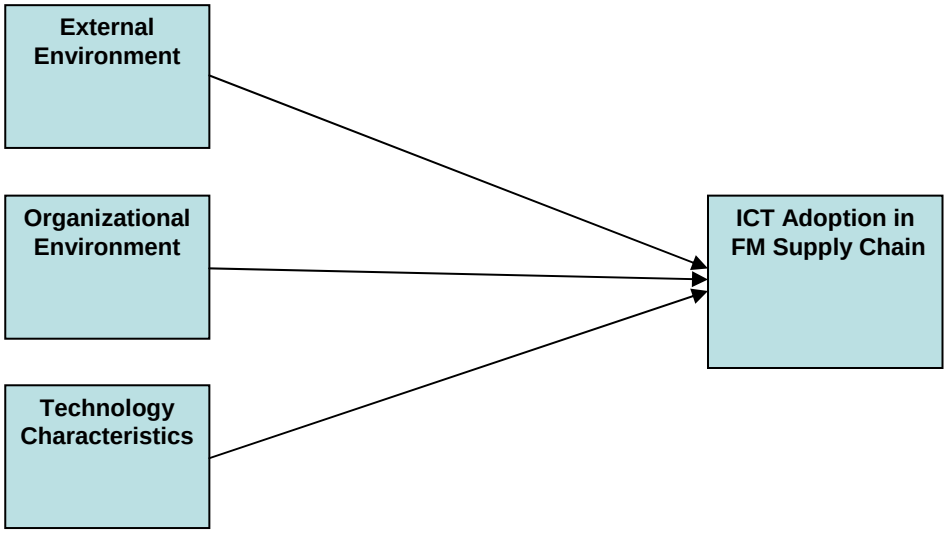
The mentioned key drivers are synthesized in table 1.

Key drivers	**External Environment**	**Organizational Drivers**	**Technology Characteristics**
	Customer/Supplier interdependence	Managerial IT knowledge	Relative advantage
	Competitive intensity	Centralization	Compatibility
	IT activity intensity	Formalization of IT unit structure	Complexity

Table 1: Synthesis of Key Factors impacting IT Adoption in the Supply Chain

Based on the literature review above it is proposed that the external environment, the organizational characteristics (drivers and barriers) as well as the technology characteristics all influence adoption of ICT systems in the supply chain of FM, therefore the model shown in figure 1 is proposed.

Figure 1: A Model of Key Factors influencing ICT Adoption in FM Supply Chain



5. Research Method

A critical issue in answering the research question was whether to use a quantitative research method such as a survey or a qualitative research method such as interviews. Here the choice to use a qualitative research method has been made because it is considered important, in first place, to qualitatively understand the factors that might be peculiar to the FM industry. In fact, even though studies have investigated ICT adoption in the supply chain in general (e.g. Ranganathan et al., 2004; Johnson and Whang, 2002), this is the first study that particularly focuses on facilities services. This methodology in the investigation of adoption and diffusion related research questions is further justified by Rogers (1995, p. 390) who states: "data about the innovation process are obtained by synthesizing the recallable perceptions of key actors in the innovation process, written records of the organization adopting, and other data sources".

The research has been designed by first conducting a thorough literature review of studies investigating IT adoption in the supply chain. With this background in mind, a number of qualitative interviews have been conducted. Here a selection of companies that are already adopters of ICT systems in the supply chain has been made in order to understand the reasons leading to adoption. Understanding these factors should help other companies and researchers to make a decision. In a second phase of the research, it is intended to use these results to conduct a comprehensive survey of factors affecting IT adoption in the FM supply chain in Denmark to further test these qualitative results. This research design has been successfully employed in other studies (Chong and Bauer, 2000).

Data for the study were gathered from archival sources, interviews with companies as well as attendance to practitioner conferences and workshops on the topic of IT systems in FM. The participant lists of these seminars and conferences, the web site of the Danish Facilities Management network (http://www.dfm-net.dk) as well as discussion with industry experts were used to find relevant companies and people to interview. In all, representatives from 12 organizations were interviewed. Only two companies were unwilling to release an interview due to company policy.

A mix of FM service providers, FM customers and FM ICT system providers was chosen to help reveal differing factors affecting the adoption and implementation of ICT systems in facilities management supply chain. In FM service providers and FM customer organisations, the respondents were high level managers responsible for FM ICT systems investment, application development and usage. In software companies providing and selling IT systems solution for FM supply chain management, high level managers and directors were interviewed. Software vendors and providers have been selected as it is believed that they have a good insight about the factors that influence IT adoption both in the service provider and the customer. Table 2 provides a summary of the characteristics of the companies interviewed.

All interviews were conducted in the period December 2008-March 2009, and each lasted circa 1.5-2 hours. Interview questions were semi structured (Yin, 2003) attempting to elicit the variety of factors that affect adoption of supply chain management IT systems in both FM providers and customers. All interviews were tape-recorded and transcribed. Notes were also taken during the interviews. To increase reliability an interview protocol was used and a database was developed (Yin, 2003). This protocol was slightly adjusted depending on the type of company interviewed: FM providers, FM customers or IT system providers.

Company type	No.	Person interviewed	Number of employees	FM ICT system
Big FM provider	A1	Department Senior Manager	250 in Denmark 4000 In Scandinavia	A system to handle reports on the tasks accomplished at the customer site, as well as a database. It is also used for forecasting. It is web based and the managers at the costumer's site can log in and input and look at the data. Maximo
IT System provider	A2	Department Manager	25	Web-based system to handle the maintenance, space management and operations of buildings
Big Consulting company in the building and FM market	A3	Head of the FM department	45 in the FM Department	Have developed their own IT system, but also use FM systems developed by other companies. It depends on the customer needs and wishes.
Big FM provider	A4	Developmen t Director	(company prefer to keep size undisclosed)	Have developed their own complex system. They are heavily relying on this system for their existence. Partially based on ERP systems.
Big Pharma Company	A5	FM Department Director	90 people in the FM Department (company prefer to keep size undisclosed)	Earlier had a pure FM system (FM anywhere, web based). Nowadays they have developed a module for FM within the ERP system called EAM, which is not web based; use a lot of e-mails and telephones
Consulting Institution	A6	Construction Consultant	Ca. 850	Have been involved in consulting services involving the use of ICT systems in FM
Big Public FM Organizations	A7	FM Manager	170	Are in the process of developing and implementing a web based system to coordinate FM tasks with external suppliers and consultants; ICT systems include Navision Stat, Byggeweb
Big Public Organizations	A8	FM Manager	45,000 employees in total. 15 in the FM department, FM dept. only takes care of building and basic installations maintenance and new construction	Web portal for e-procurement (but uses mostly e-mail) Excel for FM Planning Caretaker for FM data collection (used only internally, not in communication with suppliers) Byggeweb (not very used)
Big State /private Organization delivering experience services	A9	FM Manager	Ca. 1100	They have just installed a web-based FM system for supply chain management and are in the process of uploading older data and teaching their suppliers about how to use it.
IT System provider for FM	A10	Director of the Danish Subsidiary	6 in Denmark, Circa 12 in the Main office located abroad	DriftChefen
Big Financial Service Firm	A11	FM Manager	FM is organized as an intern function with 160 employees	DriftChefen
SME providing FM Service to mostly big corporations	A12	Manager also in charge IT	Ca. 145 managers Ca. 430 FM workers	They use different systems. Sometimes they suggest the customers to start adopting a system, most of the times it is the customer imposing them the use of a specific system in order to conduct business with them.

Table 2. Characteristics of the Companies interviewed

The protocol questions were organized into two parts. The first captured company background information such as type of business, years in business, facilities management activities and use of IT in facilities management. This information were supplemented by information provided on the companies' web site, annual reports, sales brochures and other material provided by the companies or collected in the practitioner workshop and conferences where the author participated.

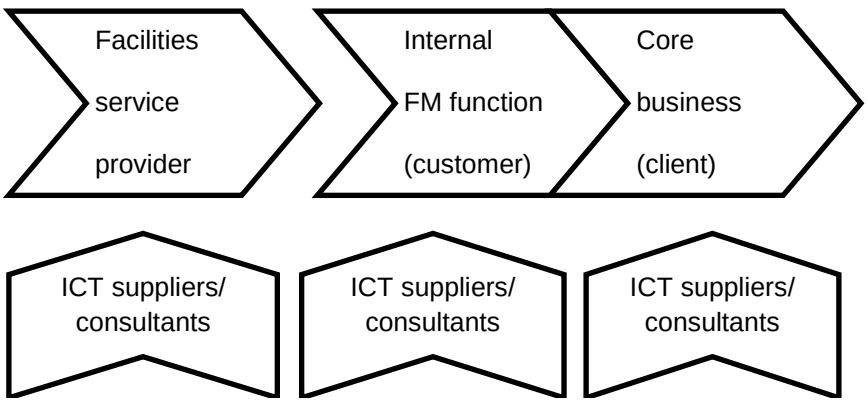
The second part specifically aimed at collecting information about the significant factors affecting adoption of IT systems for facilities management supply chain. These questions were very broad, giving the possibility to account for as many factors as possible, even though based on the literature review. The interviews were semi-structured and open ended in order to collect as much information as possible. In addition, each interview ended by inviting the respondent to add anything else that could have affected FM IT systems adoption in his/her company.

This research design is based on Miles and Huberman (1994, p. 58) suggestion to create a provisional "start list" of codes prior to the field work to guide the analysis. The coding was manual. Table 3 provides a summary of the characteristics of the companies interviewed. Figure 2, instead, shows how these organizations are placed in relation to each other in the FM supply chain. Both ICT suppliers and consultants can be providers to both facilities service providers, internal FM functions (FM customers) and the core business organization (client). A total of 10 different FM ICT systems were covered by the interview, see table 4.

Sector	**FM Service Provider**	**FM Service Customer**	**ICT Supplier/ Consultants**
Number of Companies in Each Sectors	3	5	4
Number of Companies in Each Subsector		2 FM service customer with own FM department 2 mainly outsourcing FM service to external providers	2 ICT suppliers 2 consultants

Table 3. Characteristics of the Companies by Sector

Figure 2. The Companies in the FM Supply Chain



FM ICT system	Description
Byggeweb	Danish web-based project-web system for storing and exchange of documentation about building projects and existing buildings. Developed and introduced in 1997 by the company Byggeweb A/S, who also has developed CoreFM.
Caretaker	Danish FM systems with main focus on O&M. Developed and introduced in 1994 by the consulting company COWI. Caretaker is used by many Danish municipalities.
CoreFM	Danish CAFM system with main focus on space management. Developed and introduced in 2004 by Byggeweb A/S.
DriftsChefen	Icelandic FM systems with main focus on O&M. Developed and introduced in 1995 by the consulting company ICEconsult.
EAM	International asset management system with main focus on maintenance. EAM is marketed internationally by the IT company Infor.
FM Anywhere	Danish FM systems with main focus on O&M. Developed and introduced in 2004 by the consulting KeyCon.
Maximo	International maintenance system from 1984 marketed by IBM
Navision	International ERP system marketed by Micosoft. A version called Navision Stat is targeted towards state institutions
SAP	International ERP system developed and marketed by the German company SAP AG
Vista FM	International FM system also called TAC FM with main focus on O&M. Developed in 1991 by the Finnish consulting Granlund and marketed internationally by the building automation company T.A.C. – part of Schneider Electric

Table 4. FM ICT Systems in the Interview Survey

6. Analysis and Results

6.1 Information and communication technologies (ICT) use

The results show a complex and fragmented picture of adoption and uses of ICT in FM supply chain in Denmark. Some companies are using only one ICT system; others are using several systems that not are necessarily communicating with each other. Still other companies have acquired and installed different systems, but they are still using the most well known systems such as Excel for decision making. It looks like there is no specific system really prevailing on the market, even though a couple of them were mentioned by a few companies to start being more common.

According to a system provider of web-based FM solutions for FM supply chain, circa 20% of the Danish companies that could be potential adopter of an ICT system have already adopted one. ICT systems in support of FM supply chains are seen first of all as a recording and data collection systems that need to be used on a daily basis at operational level if they have to add value to the company's operations and decision making in general. On the other hand such systems may reveal to be very valuable in operation planning and control and provide the basis for improved management decision making regarding FM provision to customers and have contributed to make work practices more systematic and stringent, thus making it easier to "manage". They are also used by middle and upper management to make decisions regarding the service level, budget, future FM investments. FM ICT systems are

also used for e-procurement and for communication with the users of the buildings (A8). We can conclude that FM ICT systems can be of great value to a corporation if used appropriately and can support not only one specific FM level (operational, tactical and strategic) but all of them in different phases of service provision/consumption and with different purposes.

6.2. Factors affecting ICT adoption and assimilation within the organizational context: drivers and inhibitors

The study reveals that there are a number of organizational drivers and inhibitors that influence ICT systems adoption and assimilation in FM supply chain management, summarized in table 5. The study shows that the key organizational factors that initiated ICT adoption in FM supply chain are top management leadership and vision, the decision to outsource FM operation to an external service provider, return on investment, the company's growth and expansion that made necessary the need to have an overview on the buildings and related FM expenditures (therefore company size).

Organizational Drivers and Barriers	Organizational Drivers	Organizational Barriers
	Improved control over the data that are being handed to the service providers in the outsourcing situation (A2) and data gotten from the service provider (A7) Better FM management decisions (A1) Better long and short term planning and forecasting of FM resources (A7) Better overview and control over the budget and the activities to be done (A3, A6, A5, A8) Better servisering of customers (A1) Top management support through organizational policy (A8) Return on investment and improved efficiency (A4); Being closer to the clients and the users of services through direct communication (A4) Get around gate keepers (A4); Source of innovation (A4); Overblik of the "bolig masse" by making it visual (e.g. 3D) (A6, A8) The right information to give to the service provider or internal FM people (A6) Better working conditions by having all the info in one place (A6; A7) Political Decision due to state requirements (A7, A8) Need to keep FM knowledge in house when the FM task is outsourced (A7) Need to keep all the FM and buildings info in one place in periods of growth or buildings extensions (A7) Improved quality assurance of the service delivered (A7) Cost Transparency (A5) and capability to link costs to each activity (A5)	Employees resistance to change at the operational level Lack of FM education (A1, A2, A6, A7, A9, A10) Lack of training and resources to learn the new system (A2, A6, A9, A10) Lack of IT competence (A1, A2, A6, A7, A8, A9, A10) Fear of flying (A1, A8) Building owner do not know what to ask from FM in the construction phase (A6, A7) Lack of knowledge at the building owner about how to incorporate FM in the building phase and how to use IT for it. (A6, A7, A8) Difficulty to incorporate in the contract the process of how to get data from the service providers (A7) Lack of language skills (e.g English) (A5, A9) Lack of resources to implement the ICT system and to make the necessary organizational changes in order for the system to get implemented (A10)

Table 5: Organizational Drivers and Inhibitors

Adoption Drivers

The decision to outsource FM activities to external service providers has created new challenges regarding the company's FM knowledge, especially since the FM external service

providers could potentially change periodically due to the limited time procurement contracts. Therefore the need to keep such FM knowledge in-house has been one major factor to adopt the FM ICT-system. This ICT system can centralize FM knowledge in one place where it can be accessed both by the service provider and the service customer as the following statement shows:
It is a decision that has been made that we must outsource … not only we outsource, we have to tender in four year contracts, and this made by outsourcing, first we moved all knowledge of our buildings outside our organization and then by doing in four year contracts we assured that any knowledge that our external had about our buildings disappears every four years. So it's been a very vital factor that we need to take all of the information and bring it home again into a system (A7).

Top management also has an important role in the adoption decision as pointed out by A8. In addition company size and company growth also influence the adoption decision. This is because as the company grows there is the need to centralize the FM information in one place to make it easier for employees to access FM related information in order to make the right decisions. Also the establishment of a FM help desk is seen as a good solution to immediate FM service response, but it can only be justified by the size of the company as the following statements show:
I think one of the factors is that we've… experienced .. a rather large growth and …they just don't have that level of detail so .. there's absolutely no way you can avoid putting this data together (A7)
Size is an important factor to have a help desk.. . (A5)

Service providers and consultants might decide to adopt FM ICT system because they see them as a market opportunity or because they are forced to do so if they want to conduct business with a certain customer (A3).

Return on investment and efficiency are also key factors influencing the adoption decision as a big service provider states:
Return on investment and efficiency, that is the only reason that we can find out to invest in (A4)

Assimilation Drivers
There are a number of organizational factors that influence the assimilation of ICT in FM supply chain, including better overview of the activities and the budget, better decision making, better communication with customers, more systematic ways of recording and analysing data. For example a manager of an FM service provider mentions how ICT FM systems have helped them to be more systematic in conducting their work and how it can help them to manage, improve efficiency and make better service development decisions, thus in general providing a competitive advantage and added value to the company.

Respondent A7 points out how the wish to have a better overview of the FM budget and FM activities as well as the drive to make better FM management decisions have been also important drivers to assimilate the FM ICT systems in their company:
But also there have been a number of demands for a better overview and better data to make management level decisions ..and you know data mining and making management level decisions and that's also are rather large wish (A7)

In addition ICT systems make it easier and faster to get the information needed to make FM decisions as showed by the following statement:
This would often be something that would take .. weeks of manual work …and now we have…a much shorter answering time. (A7)

Another major organizational driver in assimilation is better communication between the supplier and the customer, making service providers and service customers feel closer to each other as well as making it easier to go by gatekeepers and communicate directly with the relevant people:
Of course we are much closer to the clients and the users of our services and we can communicate directly with them. It has helped us get around gate keepers…(A4)

A big importance for proper ICT assimilation is also the organizational policy and ICT system implementation strategy used by the company. If the adoption and assimilation decision is made centrally and enforced throughout the company by top management the assimilation might be more satisfying than situations where the assimilation decision is left to each employee of the company as the following shows:
We see that where they make a central decision … the project are not the problem, they have decided to go for this and that is ok, ….(A3)

Adoption and Assimilation Barriers
There are also a number of barriers that slow down adoption and especially implementation of FM ICT systems. Important ones include lack of resources to learn how to use the system, lack of knowledge from the building owner about what they would like regarding FM form in the future of the building, lack of competences.

An important organizational barrier to FM ICT systems adoption is that usually at the point of construction the building owner does not know what he/she would like from from FM afterwards. Therefore they underestimate FM and the data collection process related to it. This is already important to take place at the stage of planning and construction of a building as the following citation shows:
As a building owner you can also see what is it that you would liketo have from FM afterward. What do we need afterwards? (A6).

An important organizational barrier is also the lack of resources to dedicate to learn how to use a new system as often pointed out in the literature *(A6).*

The ICT systems offer many advantages and opportunities to be accurate and stringent with the FM data. On the other hand accuracy and standardization can also be a barrier to assimilation as showed below:
I see one of the downside is that you have to adjust for stronger demands for accuracy and standardization and a certain systematic way of doing everything. …For some of our own people this has been a sort of a stone in the road which they have to overcome and I know this is very much at the operative level (A7).

Another major factor slowing down assimilation is also employees' competences that can be either ICT use related or English language related, especially for employees using the system at operational level *(A5).*

6.3 Technology Related Drivers and Barriers

The study shows that there is a number of technology related characteristics that influence both adoption and assimilation of FM ICT systems in the supply chain as showed in table 6.

Technology	Benefits	Barriers
	Give quick overview of the situation at the customer site and be able to serve the customer better (A1) The customer get a better overview of the service providers' service quality (A9, A10) Increased control and systematization in data collection and service delivery (A1, A7, A8, A10) Faster service delivery and response to help situations (A1, A9) Better control of the tasks accomplished by the service provider (A9, A10) Better specification and measurement of the desired services (A10) Employees got more control of their dailywork (A10)	The ICT systems are too complex to use (A2, A6, A5, A8, A9, A10) Continous updating and inserting the information in the system (A3, A8) Data validity (A8) Lack of standard format and classification schemes for FM data (A6, A7, A8, A9, A10) The easiness of use is not good enough (A6, A5) Incompatibility of different systems, implying a lot of re-keying if it is necessary to change the system (A5; A8) Nye software versions making it more complicated to learn how to use the system (A6)

Table 6: Technological Drivers and Inhibitors

Drivers

One of the assimilation drivers is that FM service providers can get a better and quicker overview of the situation at the customer site and be able to provide a better service (A1). Another important technology driver is a better overview over the activities that need to be done as well as budget, resource management and better data integration. Another important factor is making it easier to control that the planned activities really get implemented and therefore employees' control :

It is a planning system and it is a control system… so it is very easy to control our maintenance has been done...(A5)

Normally you have double or triple accounting..here you get a much better overview over the budget and the activities you need to have done (A3)

In addition the possibility to visualize the data as well as have intelligent buildings could be an important potential driver in the future *(A6).*

Barriers

A major technology related barrier is found in the daily use of the system and in the updating of the data in the system. In fact if this is not done in a very systematic and stringent way, then the data might not be valid and the decisions might be taken on a wrong basis. So, if a company decides to adopt such a ICT system it is important to keep the data up to date, otherwise they cannot be used for decision making, as the following citation shows:

The problem is …the use of the system and as a matter of fact looks like a complicated task every time updating what has been done and what has not been done ..(A3)

Other major barriers are the lack of classification schemes and standard formats to represent the data to be inserted into the facilities management ICT system (A8), the lack of communication and compatibility standards between the different ICT systems as well as the lack of knowledge from the building owner about what they want with facilities management as the following citations:

I think that one of the barriers is that to use the system you need classification systems all this classification and standardization is new to everyone including the system developers (A7)

6.3 External Environmental Factors

The study found that one main external factor that influence ICT adoption in the facilities management supply chain is suppliers' or customers' suggestions, requirements or pressures as it is known from the literature on inter-organizational systems adoption, see table 7. Often customers request suppliers to adopt their own ICT systems in order to be able to conduct business together or vice versa. Sometimes the adoption is a prerequisite for conducting business together and therefore mandatory, sometimes it is a suggestion that might lead or not to the adoption of that system. This depends on the FM activity that has to be done, the specific contract the customer and the supplier engage in and, especially, the power relationship between the 2 companies engaging in a supply chain relationship. In any case this condition shows that definitely there is supplier interdependence among the companies (e.g. A3).

External Drivers/ Barriers	**External Drivers**	**External Barriers**
	Supplier Interdependence-FM provider or customer (in an outsourcing situation) are forced to accept the partners' system (A7, A4, , A3, A12,) Improve and control relationships with FM Service Provider (A2, A12); Market opportunity (A3) Clients ask for single point of contact (A4) Political decision (from the ministry) to outsource (A7) Knowledge acquired in different networks (A7) Forecasting that requirement on "Den digital FM system" could come within 1-2 years (A9) Job market flexibility (A7)	Lack of collaboration among software providers, building owner and users in developing ICT systems (A6) Government Regulation (validation)(A5) Sub-suppliers not knowing Danish if they are Germans or Polish (A9) Disagreement between the service provider and the customer about the data needed to be delivered (A8) Critical mass of users (A8)

Table 7: External Drivers and Inhibitors

Politicians, policy makers, regulation also have an important role especially in public organizations such as A8 and A7. In other cases, more complicated, the customer may require a single point of contact with the service provider and if the services provided are many or complicated, this task is impossible to be handled by only one person, so the single point of contact becomes the ICT FM system. In this case the ICT system might vital for the existence of the service provider, as the following citation shows:
Resp. Major reason is that the clients ask for single point of contact .. It (ICT) is included in our base price, they cannot negotiate, without that we are not able to make things work. It is how simple it is (A4).

On the other hand the type of industry the company is in might influence the type of ICT system to use in the company. For example a company had a web-based system that was not validated by some industry organizations and therefore they had to switch to an enterprise resource planning (ERP) system which was not web-based, implying that a lot of data have to be typed in manually into the system on a daily base:
So before that we had a web based system ...but the problem with that system was that they could not ... validate the system … (A5)

Also job market flexibility, especially in periods of high economic growth, implying high turnover of employees and therefore the need to keep the information and knowledge that employees have in a central place might have an impact on the adoption of FM ICT systems: *…Our employees disappear as well, so the flexibility of the whole setup and also of the job market has been a big factor in the decision in putting our information into an IT system (A7).*

Supplier Interdependence
As discussed in the literature review, the concept of supplier interdependence has resulted as a very important factor influencing ICT adoption in the supply chain. This is very understandable as in the supply chain what the service provider does influences the customer and vice-versa due to the definition of supply chain. In our study we found that this factor is indeed important also in FM supply chain *(e.g. A1).*

The study also shows that in understanding SCM issues it is important to take into perspective different actors from the supply chain. For example in order to have FM ICT systems that are easy to use and meet the FM clients or providers needs, it is important that software providers, building owner and users collaborate in order to specify what the characteristics of such a system should include (e.g. *A6).*

In the supplier interdependence a major issue is coordinating and formally writing in the contracts between supplier and customer when and in which format the data need to be delivered:
The simple thing of making sure …that we have described also in our contracts the correct processes so we get data when we need to work with them.. that's a rather large piece of work which we're still working on (A7)

7. Concluding Discussion

This article has presented the results of a study of factors impacting ICT adoption in the supply chain of FM in Denmark. The study has showed that ICT systems for supply chain in facilities services are starting being adopted and used by companies, but still to a limited extent. The findings show that this is the case mainly due to the characteristics of the ICT systems, that are not that user friendly and often incompatible with each other, the lack of standards and classification schemes for inputting the data into the system as well as the lack of knowledge and awareness of the building owner about what they want from the facilities services after the building has been built.

The study shows that there are a number of important external drivers of ICT systems adoption among which the outsourcing trend and relative need to keep at least some of the data in house, the market flexibility, government regulation, and factors that go under the name of customer-supplier interdependence such as improved customer relationships.

The study found a number of organizational and technological drivers and barriers of ICT adoption. Among the drivers there are better FM management decisions, better long term and short term planning and forecasting of FM services and resources, better overview and control over the budget, as well as increased systematization in data collection and service delivery. Key barriers include the difficulty of writing in the service contract the process of how and when to get data from the FM service providers, lack of resources to implement the ICT

systems and to make the necessary organizational changes in order for the system to get implemented.

This study has important implications for FM service managers and FM ICT systems developers. ICT systems developers should try to improve such FM systems to make them more user friendly and especially find an easy way to categorize and standardize the different facilities elements and components. On the other hand facilities managers and FM organizations should be aware of the advantages brought by such systems, not only for internal efficiency and customer-supplier relationships, but also for keeping the facilities services knowledge in house especially when FM is outsourced.

One of the external drivers for customer organisations is as mentioned the trend towards outsourcing. The risk of losing data about the organisations facilities, when switching between different service providers, gives the customer organisations incentives to keep control over their own FM data. This can have important consequences for the way customer and provider companies collaborate on ICT systems and how they use and exchange information. It also opens up a potential increased market for ICT suppliers, who offer to host and operate systems as Application Service Providers for FM customer companies, who want to have control over their FM related information independent of which FM service providers they use over time.

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